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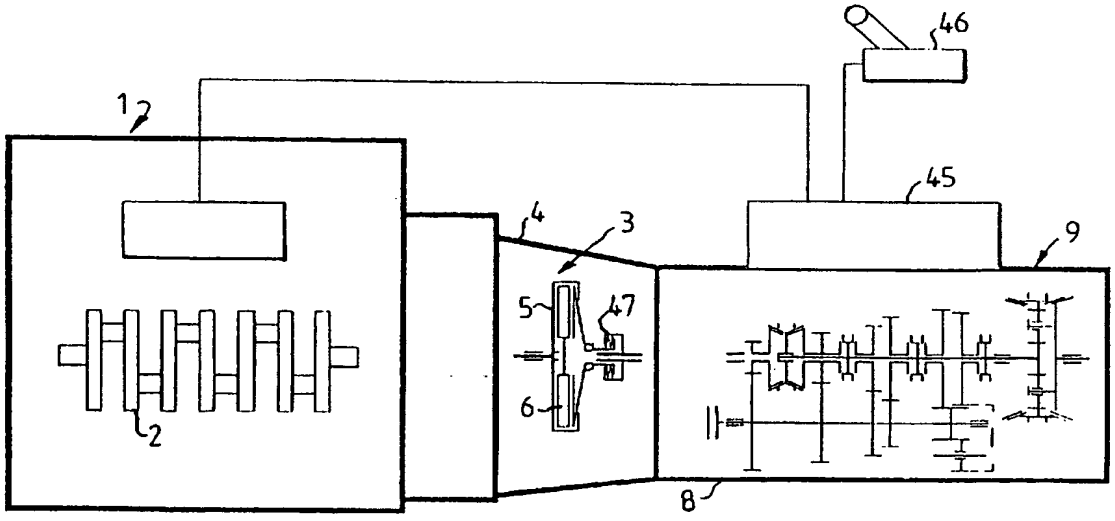
(54) Title: DRIVE MEANS FOR MOTOR VEHICLES



(57) Abstract: Drive unit for motor vehicles, comprising an internal combustion engine (1) and a non-synchronized auto-shift gearbox (9), which has an intermediate shaft 850) and is connected to the engine via an automated clutch (3). The clutch and the gearbox are controlled by an electronic control unit (45), to which there are fed signals representing the selected gear from a gear selector (46) and signals representing various engine and vehicle data. The control unit is disposed, when the gear selector is in the neutral position, the clutch is engaged and the vehicle speed is so low the synchronisation by means of the engine requires an engine rpm lower than the enging idle rpm, to first disengage the clutch, then brake the intermediate shaft to a standstill, thereafter engage the clutch slowly and finally engage the selected gear, when the input shaft has reached a suitable rpm range for engagement of the selected gear.

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Drive means for motor vehicles

The present invention relates to a drive unit for motor vehicles, comprising an internal combustion engine and an auto-shift gearbox input shaft connected via an automated disc clutch to the engine crankshaft, said auto-shift gearbox having at least one intermediate shaft mounted in a housing, said intermediate shaft having at least one gear in engagement with a gear on the input shaft, and brake means, by means of which the rotation of the intermediate shaft can be rapidly braked to zero upon release of the clutch, a main shaft which is mounted in the housing and has gears engaging gears on the intermediate shaft, at least one gear in each pair of interengaging gears on the intermediate shaft and the main shaft being rotatably mounted on its shaft and lockable by engaging means of which at least the engaging means of some forward gears lack a synchronization function and operating means which cooperate with the engaging means and are controlled by a control unit connected to a gear selector, signals being fed to said a control unit representing the selected gear and various engine and vehicle data, at least including engine speed, input shaft rotational speed, vehicle speed, clutch position and accelerator pedal position.

Drive units of this type with so-called auto-shift gearboxes have become more and more common in heavy vehicles as microcomputer technology has been developed and made it possible, with the aid of a control computer and a number of control means, e.g. servomotors, to precision-regulate engine speed, engagement and disengagement of the clutch and gearbox coupling means relative to each other, so as to always provide smooth shifting, even when shifting between unsynchronized gear steps. The advantage of an auto-shift transmission over a traditional automatic transmission, made up of a planet gear stage with a hydrodynamic torque converter on the input side, is, on the one hand, particularly when used in heavy vehicles, that it is simpler and more reliable and can be manufactured at a substantially lower cost than traditional automatic transmission, and, on the other hand, that it has a higher

efficiency, making lower fuel consumption possible. In a gearbox made up of a non-synchronized auto-shift main group and a range group, the absence of synchronizations reduces costs even further. The absence of synchronization means makes it possible to make the gearbox shorter or, alternatively, with a set length, to make the gears wider than in a synchronized gearbox of the same length, to thereby make it possible to transmit higher torque.

When the vehicle is standing still and the gear selector is in the neutral position, the clutch is normally engaged, so that torque is transmitted from the engine via the clutch to the input shaft of the gearbox and thereby also to its intermediate shaft. This arrangement is often used to drive the gearbox lubricant pump, the gearbox bearings thus being lubricated in this manner even when the gearbox is in neutral when the clutch is engaged. When the vehicle is to start moving, the clutch must first be disengaged before a starting gear can be engaged. If the gear to be engaged is a non-synchronized gear, the interengaging gearwheels on the main shaft and the intermediate shaft must be braked down to almost a standstill before the gear can be engaged. Gearboxes of this type often have very small losses, which means that it would take too long from disengagement of the clutch until the rotating components of the gearbox came to a stop, if the rotating components were not actively braked in some manner. A known method is to use an intermediate shaft brake which rapidly brakes the intermediate shaft down to a standstill when the clutch is disengaged.

In a drive unit of the type in questions, the problem arises of how to comfortably engage an unsynchronised gear speed at low vehicle speed without producing a scraping sound in the gearbox. If the vehicle speed is so low that it would require a lower engine rpm than its idle rpm to use the engine to synchronise the input shaft rpm with the rpm of the selected gear speed, and is so high that the intermediate shaft brake cannot be used to brake the intermediate shaft, the gear can be engaged without scraping only by delaying a number of seconds after clutch release until the input shaft rpm has dropped to a suitable rpm. Depending on the moments of inertia

of the rotating masses and the temperature of the oil in the gearbox, the delay required before permitting scraping-free shifting should amount to between five and ten seconds.

The purpose of the present invention is to achieve a drive unit of the type described by way of introduction, which obviates the above mentioned problem by making possible rapid and comfortable gear engagement without scraping, when the vehicle speed is so low as to make impossible synchronisation using the engine, but so high that shifting directly after stopping the intermediate shaft by means of its brake cannot be effected without scraping.

This is achieved according to the invention by virtue of the fact that the control unit is arranged – when the gear selector is in the neutral position, the clutch is engaged and the vehicle speed is so low that synchronisation for the selected gear with the aid of the engine requires a lower engine speed than the engine idle speed – upon moving the gear selector to the selected gear selection position to effect in sequence: releasing the clutch, activating said brake means to rapidly brake the rotation of the intermediate shaft at least to near standstill, engaging the clutch so that the input shaft is accelerated slowly, and activating said engaging means to engage said gear when the input shaft has reached a suitable rotational speed range for engagement of the selected gear.

In a preferred embodiment the control unit is arranged under said preconditions to first put the clutch in initial engagement position and then slowly increase the clutch engagement, to accelerate the input shaft up to a suitable rpm range. For identification of initial clutch engagement position and controlling the clutching there is preferably used a control unit of the type which is shown and described in WO 01/17815

The invention will be described in more detail with reference to examples shown in the accompanying drawings, where Fig. 1 shows a schematic representation of a drive unit according to the invention and Fig. 2 shows the clutch and the gearbox of Fig. 1 on a larger scale and Fig. 3 is a diagram showing input shaft rotational speed as a function of the clutch disengagement and engagement sequence.

In Fig. 1, 1 designates a six-cylinder internal combustion engine, e.g. a diesel engine, the crankshaft 2 of which is coupled to a single-disc dry-disc clutch, generally designated 3, which is enclosed in a clutch bell 4. Instead of a single-disc clutch a dual-disc clutch can be used. The crankshaft 2 is solidly joined to the clutch housing 5, while its disc 6 is solidly joined to an input shaft 7, which is rotatably mounted in the housing 8 of a gearbox, generally designated 9. A main shaft 10 and an intermediate shaft 11 are rotatably mounted in the housing 8.

As is most clearly evident from Fig. 2, a gear 12 is rotatably mounted on the input shaft 7 and can be locked to said shaft with the aid of an engaging sleeve 13 provided with synchronizing means. Said engaging sleeve 13 is non-rotatably but axially displaceably mounted on a hub 14 non-rotatably connected to the input shaft. With the aid of the engaging sleeve 13, a gear 15, rotatably mounted on the main shaft 10, is lockable relative to the input shaft 7. The gears 12 and 15, respectively, engage gears 16 and 17, respectively, which are non-rotatably joined to the intermediate shaft 11. Additional gears 18, 19 and 20, respectively, are non-rotatably joined to the intermediate shaft 11 and engage gears 21, 22 and 23, respectively, on the main shaft 10 and lockable to the main shaft with the aid of engaging sleeves 24 and 25, respectively, which in the example shown do not have synchronizing means. On the main shaft 10, an additional gear 28 is rotatably mounted and engages an intermediate gear 30 rotatably mounted on a separate shaft 29. The intermediate gear 30 engages in turn an intermediate shaft gear 20. The gear 28 is lockable to its shaft with the aid of an engaging sleeve 26.

The gear pairs 12, 16 and 15, 17 and the engaging sleeve 13 form a splitter group with a low stage LS and a high stage HS. The gear pair 15, 17 together with the gear pairs 21, 18, 22, 19, 23, 20 and 28, 30 form a main group with four speeds forward and one reverse. At the output end of the main shaft 10, a gear 31 is non-rotatably mounted to form the sun gear in a two-range group of planetary type, generally designated 32, the planet carrier 33 of which is non-rotatably mounted to a shaft 34, forming the output shaft of the gearbox. The planet gears 35 of the range group 32 engage a ring gear 36 which, with the aid of an engaging sleeve 37, can be locked relative to the gearbox housing 8 for low range LR and relative to the planet carrier 33 for high range HR. The engaging sleeve 37 also has a neutral position NR lying between low range LR and high range HR, in which neutral position the output shaft 34 is released from the main shaft 10.

The engaging sleeves 13, 24, 25, 26 and 37 are displaceable as indicated by the arrows in Fig. 2, providing the gear positions indicated above the arrows. Displacement is achieved by servo means 40, 41, 42, 43 and 44, schematically indicated in Fig. 2, which can be pneumatically operated piston-cylinder devices of the type used in a gearbox of the above described type, which is marketed under the name Geartronic®. The servo means are controlled by an electronic control unit 45 (Fig. 1), comprising a microcomputer depending on signals fed into the control unit representing various engine and vehicle data, including at least engine speed, vehicle speed, clutch and accelerator pedal position and, where applicable, engine brake on-off, when an electronic gear selector 46 coupled to the control unit 45 is in its automatic position. When the selector is in its position for manual shifting, the shifting occurs at the command of the driver via the gear selector 46. The control unit 45 also controls the fuel injection, i.e. the engine speed, depending on the accelerator pedal position and the air supply to a pneumatic piston-cylinder device 47, by means of which the clutch 3 is engaged and disengaged.

The control unit 45 is programmed in a known manner so that the clutch 3 is engaged when the vehicle is standing still and the gear selector 46 is in the neutral position. This means that the engine is driving the input shaft 7 and thus also the intermediate shaft 11, while the output shaft 34 is disengaged. Supplementary apparatus driven by the intermediate shaft, e.g. an oil pump for lubricating the gearbox, is driven in this position. The control unit 45 is also programmed, when the gear selector is moved from the neutral position to a gear select position, either to a position for automatic shifting or to a position with a starting-off gear selected by the driver, to first disengage the clutch 3 and brake the intermediate shaft 11 to a standstill with the aid of the intermediate shaft brake 50 shown in Fig. 2, which can be a brake means known per se and controlled by the control unit 45. With the intermediate shaft 11 braked to a standstill or nearly so, the control unit 45 now initiates shifting in the main group to a gear selected automatically or by the driver selecting a total gear speed. When the driver after gear engagement, now depresses the accelerator, the accelerator pedal will now function as a reverse clutch pedal, as the control unit gradually increases the clutch engagement as the throttle is opened.

If the vehicle is not standing completely still when the gear selector 46 is moved from the neutral position to a gear selection position, but its speed is so low that synchronising to the selected gear speed with the aid of the engine would require an engine rpm below the engine idle rpm, the shifting will be effected in the manner illustrated in the diagram in Fig. 3, where the solid line "a" represents engine idle rpm, which in the example shown is assumed to be 600 rpm. The interval between the dashed lines "b" and "c", ca 350-450 rpm, indicates the range within the input shaft 7 rpm must lie to permit shifting to the selected gear without scraping. When the gear selector 46 is moved from the neutral position the control unit 45 initiates the release of the clutch. The control unit then activates the intermediate brake 50, which rapidly brakes the intermediate shaft 11 to a standstill, as illustrated by the line "d". The control unit then initiates the engagement of the clutch 3 by first switching to pulling position and then gradually increasing the engagement until

the rpm of the input shaft 7 reaches the desired rpm range between the lines "b" and "c", as illustrated by the line "e". With the input shaft rpm within the given range, the control unit initiates the engagement of the selected gear. The control unit can, for example, be programmed to control the engagement so that the clutch 3 transfers so low torque that the acceleration of the input shaft 7 from standstill to 350-450 rpm takes 0.3-0.6 s.

Claims

1. Drive unit for motor vehicles, comprising an internal combustion engine (1) and an auto-shift gearbox input shaft (7) connected via an automated disc clutch (3) to the engine crankshaft (2), said auto-shift gearbox (9) having at least one intermediate shaft (11) mounted in a housing, said intermediate shaft (11) having at least one gear (16, 17) in engagement with a gear (12, 15) on the input shaft, and brake means (50), by means of which the rotation of the intermediate shaft can be rapidly braked to zero upon release of the clutch, a main shaft (10) which is mounted in the housing and has gears (15, 21, 22, 23) engaging gears (17, 18, 19, 20) on the intermediate shaft, at least one gear in each pair of interengaging gears on the intermediate shaft and the main shaft being rotatably mounted on its shaft and lockable by engaging means (13, 24, 25) of which at least the engaging means of some forward gears lack a synchronization function, and operating means (40, 41, 42), which cooperate with the engaging means and are controlled by a control unit (45) connected to a gear selector (46), signals being fed to said control unit (45) representing the selected gear and various engine and vehicle data, including at least engine speed, input shaft rotational speed, vehicle speed, clutch position and accelerator pedal position, **characterized in** that the control unit (45) is arranged – when the gear selector (46) is in the neutral position, the clutch (3) is engaged and the vehicle speed is so low that synchronisation for the selected gear with the aid of the engine requires a lower engine speed than the engine idle speed – upon moving the gear selector to the selected gear selection position to effect in sequence: releasing the clutch, activating said brake means (50) to rapidly brake the rotation of the intermediate shaft at least to near standstill, engaging the clutch so that the input shaft (7) is accelerated slowly, and activating said engaging means (13,24,25) to engage said gear when the input shaft has reached a suitable rotational speed range for engagement of the selected gear.

2. Drive unit according to Claim 1, characterized in that the control unit (45) is arranged, under said preconditions, for engagement of the clutch (3) to first rapidly dispose the clutch in initial engagement position and then slowly increase the clutch engagement.

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3. Drive unit according to Claim 1 or 2, characterized in that the control unit (45) is arranged to control the clutch (3) so that, under said preconditions, the input shaft is accelerated up to the suitable rotational speed range in ca. 0.3-0.6 s.

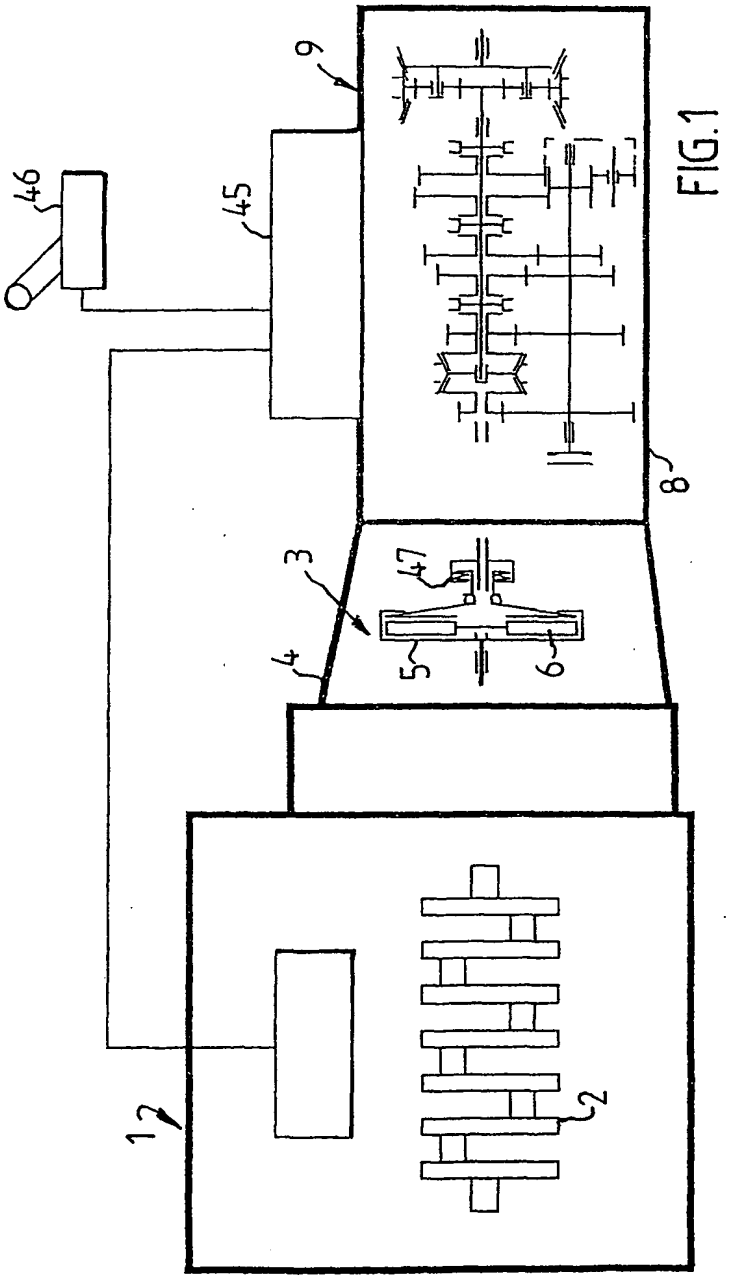

FIG.1

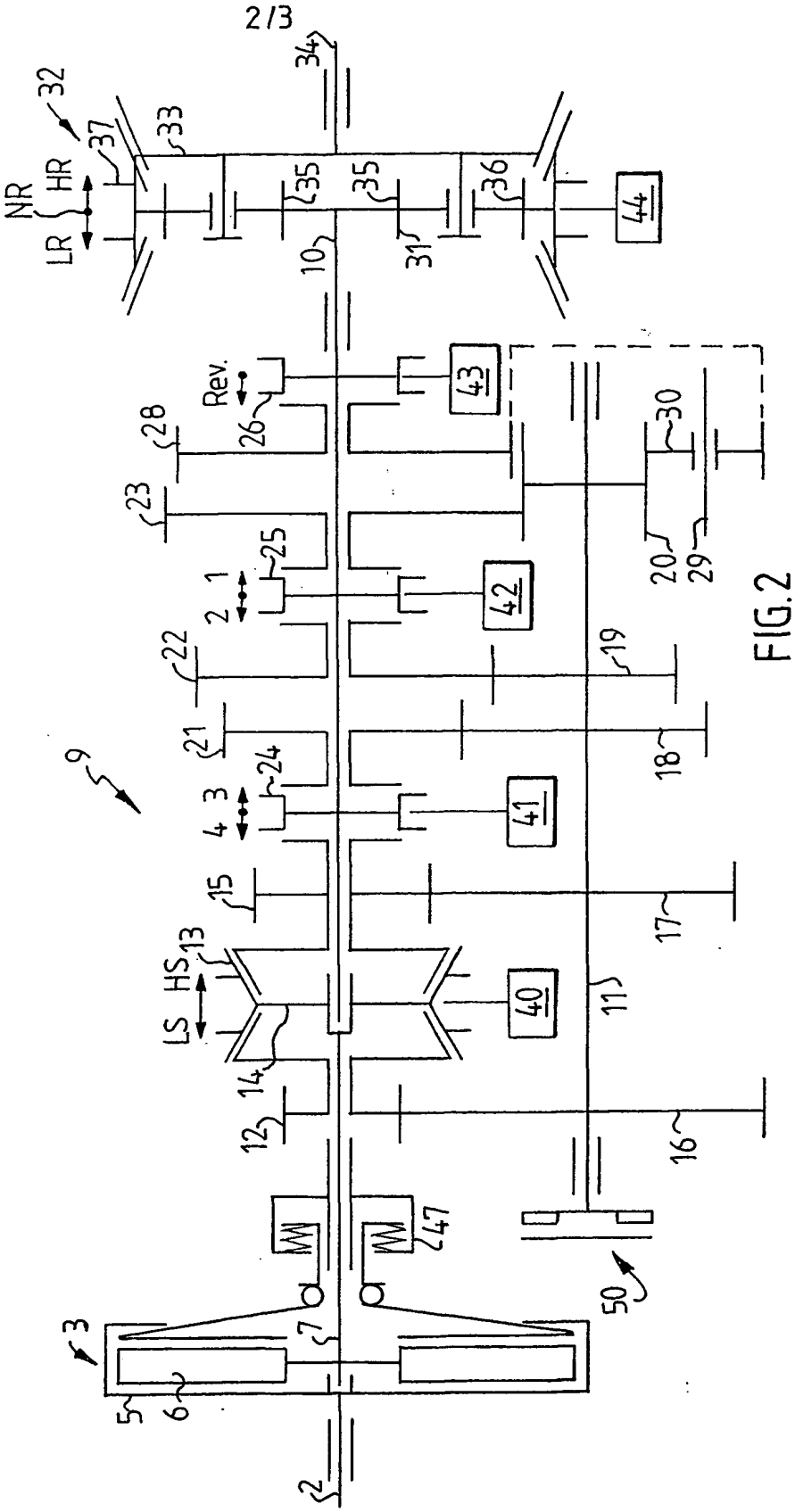

FIG.2

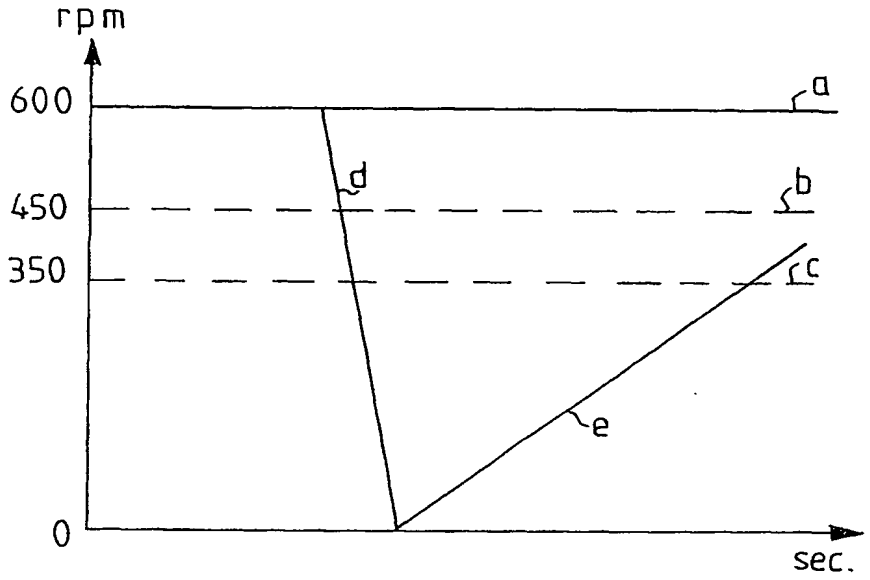

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 02/00812

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B60K 41/06, F16H 3/12, F16H 61/04
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B60K, F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4727472 A (DEUTSCH ET AL), 23 February 1988 (23.02.88) --	1-3
A	US 4294338 A (SIMMONS), 13 October 1981 (13.10.81) --	1-3
A	US 4211313 A (QUICK ET AL), 8 July 1980 (08.07.80) --	1-3
A	US 3309934 A (C.J. GUSTAVSSON ET AL), 21 March 1967 (21.03.67) --	1-3
A	US 2875872 A (T. BACKUS), 3 March 1959 (03.03.59) --	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

10/06/02

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4727472 A	23/02/88	NONE	
US 4294338 A	13/10/81	NONE	
US 4211313 A	08/07/80	CA 1094355 A	27/01/81
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US 2875872 A	03/03/59	NONE	